REMARKS

Claims 1-10, 21, 22, and 25-30 are pending in the present application. Reconsideration and allowance of outstanding claims 1-10, 21, 22, and 25-30 in view of the following remarks are requested.

A. Rejections of Claims 1-10, 21, 22, and 25-30 under 35 USC §103(a)

The Examiner has rejected claims 1-10, 21, 22, and 25-30 under 35 USC §103(a) as being obvious with respect to U.S. Patent Application Publication Number 2002/0127847 to Alling, et al. ("Alling"), U.S. Patent Number 6,398,926 B1 to Mahneke ("Mahneke"), U.S. Patent Number 3,706,635 to Kowalski ("Kowalski"), and U.S. Patent Number 6,486,533 B2 to Krishnamoorthy, et al. ("Krishnamoorthy"). For the reasons discussed below, Applicant respectfully submits that the present invention, as defined by independent claim 1, is patentably distinguishable over Alling, Mahneke, Kowalski, and Krishnamoorthy.

Embodiments according to the present invention, as defined by independent claim 1, include electroplating a copper (Cu) surface in a chemical solution, where the chemical solution comprises at least one wetting agent for stabilizing the chemical solution, wherein the at least one wetting agent is dissolved in a volume of deionized (DI) water, and wherein the chemical solution does not etch the Cu surface. As disclosed in the present application, embodiments according to the present invention provide a Cu-Zn electroplating solution that facilitates improved filling of a Cu-Zn alloy film on an

interconnect, especially for feature sizes in a dimensional range of approximately 0.2 μm to approximately 0.05 μm, thereby lowering the resistance of the formed Cu-Zn alloy film. The Cu-Zn electroplating exhibits a beneficial characteristic of not etching copper or a copper alloy seed layer, which advantageously enhances the filling capability of the Cu-Zn electroplating solution.

Moreover, the Cu-Zn alloy film is electroplated on a Cu surface using a stable chemical solution in prescribed concentration ranges. For example, the chemical solution can comprise at least one wetting agent, where the at least one wetting agent is provided in a concentration less than 0.1 g/L, and where the at least one wetting agent is dissolved in a volume of deionized (DI) water. Consequently, embodiments according to the present invention advantageously achieve improved Cu interconnect reliability, improved corrosion resistance, and reduced manufacturing costs.

In contrast to the present invention as defined by independent claim 1, Alling does not teach, disclose, or suggest electroplating a copper (Cu) surface in a chemical solution, where the chemical solution comprises at least one wetting agent for stabilizing the chemical solution, wherein the at least one wetting agent is dissolved in a volume of deionized (DI) water, and wherein the chemical solution does not etch the Cu surface. Alling teaches plating baths that employ an acidic electrolyte, which typically will be an acidic aqueous solution and that contains a halide ion source, particularly a chloride ion source. See, for example, paragraph [0030] of Alling. Therefore, if Alling is to be combined with other art of record the suggestion is with respect to plating baths that

employ an acidic electrolyte. Nevertheless, Alling does not teach, disclose, or even suggest electroplating a Cu surface in a chemical solution, thereby forming a Cu-Zn alloy film on the Cu surface, where the chemical solution does not etch the Cu surface. Further, Alling fails to teach, disclose, or even suggest a chemical solution comprising at least one wetting agent for stabilizing the chemical solution, where the at least one wetting agent is dissolved in a volume of deionized (DI) water.

Alling does not disclose, teach, or suggest the process steps of independent claim 1. Furthermore, there is no teaching or suggestion to combine or modify Alling. Therefore, Alling, singly or in combination with other art of record, does not disclose, teach, or suggest the present invention as defined by independent claim 1.

Mahneke fails to cure the deficiencies of Alling. In contrast to the present invention as defined by independent claim 1, Mahneke does not teach, disclose, or even suggest electroplating a copper (Cu) surface in a chemical solution, where the chemical solution comprises at least one wetting agent for stabilizing the chemical solution, wherein the at least one wetting agent is dissolved in a volume of deionized (DI) water, and wherein the chemical solution does not etch the Cu surface. The Examiner relies on Mahneke for providing motivation to enable the formation of the copper-zinc alloy film of Alling to be performed and obtain further advantage of preventing contamination on both surfaces of the wafer. Mahneke teaches an electroplating chamber having a rotatable chuck, i.e. chuck 44, which allows plating, rinsing, and drying steps of an electroplating process to be performed in the same chamber. See, for example, Mahneke,

column 2, lines 28-38 and column 5, lines 6 and 7. However, Mahneke does not teach, disclose, or suggest a chemical solution for electroplating a Cu-Zn alloy film on a Cu surface, where the chemical solution comprises at least one wetting agent for stabilizing the chemical solution, and where the at least one wetting agent is dissolved in a volume of deionized (DI) water.

Furthermore, Mahneke fails to teach, disclose, or even suggest electroplating a Cu surface in a chemical solution, thereby forming a Cu-Zn alloy film on the Cu surface, where the chemical solution does not etch the Cu surface, as recited in independent claim 1. Mahneke does not disclose, teach, or suggest the process steps of independent claim 1. Furthermore, there is no teaching or suggestion to combine or modify Mahneke. Therefore, Mahneke, singly or in combination with other art of record, does not disclose, teach, or suggest the present invention as defined by independent claim 1.

Kowalski does not cure the deficiencies of Alling and Mahneke. In contrast to the present invention as defined by independent claim 1, Kowalski does not teach, disclose, or suggest electroplating a copper (Cu) surface in a chemical solution, where the chemical solution comprises at least one wetting agent for stabilizing the chemical solution, wherein the at least one wetting agent is dissolved in a volume of deionized (DI) water, and wherein the chemical solution does not etch the Cu surface. The Examiner relies on Kowalski to provide the motivation to enable the step of mixing the chemical solution with a volume of water in the combination process to be performed. Kowalski discloses plating solutions prepared in deionized water by first adding potassium hydroxide

followed by a particular ligand and then a copper salt, which was copper sulfate. See, for example, Kowalski, column 10, lines 16-20.

However, the plating solution disclosed in Kowalski does not contain a zinc ion source and, as such, the plating solution cannot be utilized to form a Cu-Zn alloy film on a Cu surface. Referring to Kowalski at column 3, 53-56, a copper-zinc alloy that is plated is merely disclosed. In addition, Kowalski does not teach, disclose, or suggest a chemical solution, wherein the chemical solution includes at least one wetting agent for stabilizing the chemical solution, and wherein the at least one wetting agent is dissolved in a volume of deionized (DI) water. Furthermore, Kowalski fails to teach, disclose, or suggest electroplating a Cu surface in a chemical solution, thereby forming a Cu-Zn alloy film on the Cu surface, where the chemical solution does not etch the Cu surface, as specified in independent claim 1.

Kowalski does not disclose, teach, or suggest the process steps of independent claim 1. Furthermore, there is no teaching or suggestion to combine or modify Kowalski. Therefore, Kowalski, singly or in combination with other art of record, does not disclose, teach, or suggest the present invention as defined by independent claim 1.

Krishnamoorthy fails to cure the deficiencies of Kowalski. In contrast to the present invention as defined by independent claim 1, Krishnamoorthy does not teach, disclose, or suggest electroplating a copper (Cu) surface in a chemical solution, wherein the chemical solution comprises at least one wetting agent for stabilizing the chemical solution, wherein the at least one wetting agent is dissolved in a volume of deionized (DI)

water, and wherein the chemical solution does not etch the Cu surface. The Examiner relies on Krishnamoorthy to provide the motivation to enable the formation of the chemical solution of the combination process to be performed and obtain the further advantage of solving the diffusion and self-passivation problems in metallization structure.

Nevertheless, Krishnamoorthy fails to teach, disclose, or even suggest a chemical solution, where the chemical solution comprises at least one wetting agent for stabilizing the chemical solution, and where the at least one wetting agent is dissolved in a volume of deionized (DI) water. Further, Krishnamoorthy fails to teach, disclose, or suggest electroplating a Cu surface in a chemical solution, thereby forming a Cu-Zn alloy film on the Cu surface, where the chemical solution does not etch the Cu surface, as specified in independent claim 1.

Krishnamoorthy does not disclose, teach, or suggest the process steps of independent claim 1. Furthermore, there is no teaching or suggestion to combine or modify Krishnamoorthy. Therefore, Krishnamoorthy, singly or in combination with other art of record, does not disclose, teach, or suggest the present invention as defined by independent claim 1.

Further, the Examiner asserts that one cannot show non-obviousness by attacking references individually. However, Applicants respectfully submit that if one shows, as Applicant has done, that all of the elements of the independent claim being rejected are

not taught, disclosed, or suggested in the combination of cited art, then a rejection under 35 USC §103(a) cannot stand.

For the foregoing reasons, Applicant respectfully submits that the present invention, as defined by independent claim 1, is not taught, disclosed, or suggested by the art of record. Thus, independent claim 1 is patentably distinguishable over the art of record. As such, the claims depending from independent claim 1 are, *a fortiori*, also patentable for at least the reasons presented above and also for additional limitations contained in each dependent claim.

B. **Conclusion**

Based on the foregoing reasons, the present invention, as defined by independent claim 1 the claims depending therefrom, is patentably distinguishable over the art cited by the Examiner. Thus, outstanding claims 1-10, 21, 22, and 25-30 are patentably distinguishable over the art cited by the Examiner. As such, and for all the foregoing reasons, an early Notice of Allowance directed to all claims 1-10, 21, 22, and 25-30 remaining in the present application is respectfully requested.

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